Appln. of: Mills
Serial No.: 10/710,723
Filed: July 30, 2004

REMARKS

Reconsideration and allowance are respectfully requested.

Claims 1-17 and 39-70 are pending in this application.

Claims 53-70 have been allowed.

Under separate cover letter, the current assignee of the present application is today submitting an Information Disclosure Statement and Form PTO-1449 for consideration by the Examiner. The current assignee wishes to bring to the Examiner's attention two pending US patent applications also assigned to the current assignee of the present application that are directed to related subject matter.

The first such patent application is US Patent Application No. 10/817,739, of Erik JOHANN, filed April 5, 2004.

The second such patent application is US Patent Application No. 10/870,437, of Erik JOHANN, filed June 18, 2004.

It is respectfully requested that with the next action, the Examiner return a copy of the IDS with the two above-noted applications initialed to confirm that the Examiner has reviewed such applications.

Claims 1-3, 4/1-4/3, 5/1-5/3, 8/1-8/3, 9/1-9/3, 10/1-10/3, 11/1-11/3, 39/1-39/3, 40/1-40/3, 41/1-41/3, 44/1-44/3, and 45/1-45/3 stand rejected under 35 USC 103(a) as being unpatentable over Dorman in view of Chou.

Applicant respectfully traverses this rejection.

The phenomenon that the claimed invention addresses is one that was only recognized shortly prior to the priority date of the present application.

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Compressors with compressor blades having a large chord length, but with a reduced number of blades, have certain advantages over former designs, but have been found to give rise to unexpected stresses in the compressor disk to which the blades are attached. Investigations yielded that unexpectedly strong natural frequencies of the individual blades, i.e. second and third bending mode and first torsional mode, occur under certain flight conditions characterized by flight altitude, flight velocity, Reynolds number and Strouhal number which are transferred via the blade root to the compressor disk and cause damage to the latter. Compression shocks occur on the compressor blade in an area of approx. 45 to 70 percent of the blade width. The high pressure downstream of the compression shock subjects the compressor blade to correspondingly high forces. In addition, a boundary layer flow communicating with the compression shocks exists at the blade surface which, up to a flow transition point, is initially laminar and subsequently transits into a turbulent flow 11b. Since the flow transition point oscillates periodically, the lambda compression shock will, move between a first and a second position at a frequency corresponding to the periodic shifting of the flow transition point. Oscillation of the shock may also be caused by a change in the state of the compression shock from a strong one (vertical shock) to a weak one (lambda shock). In both cases, the second and third bending mode and the first torsional mode of the compressor blade are excited by the periodic change in shock and may, due to the coupling effect with the compression shock vibration, load the blade root such that the above-described, unexpected stressing of the compressor disk and blade occurs.

The inventive concept is to prevent, or limit, the periodic movement of the compression shocks and their reaction on the natural frequencies by fixation of the flow transition,

restricting the change-over point from the laminar to the turbulent boundary layer flow upstream of the compression shock, i.e. preventing it from oscillating, locally on the low-pressure (suction) side, to such an extent that the oscillating movement of the compression shocks and their vibration-amplifying effect on the natural frequencies of the blades, irrespective of the operating range of the compressor blades, is avoided. Thus, compressors with compressor blades can be made available which will not be damaged by the above-described, specific flight conditions.

Claims 1-3 have been amended to require that each blade have a relatively long chord length,

A high lift, relatively short chord blade as disclosed in Dorman does not encounter the oscillating movement of compression shocks that the claimed invention encounters. Such oscillation is only found on low lift, relatively long chord length blades, unlike that of Dorman. Therefore, the disclosed Dorman blade does not encounter a periodic movement of a transition point from laminar to turbulent and does not suppress such a periodic movement of the transition point and prevent the transition point from communicating with a compression shock, as required in independent claims 1-3.

Chou is directed to a blade for a centrifugal flow fan as typically used in HVAC (heating, ventilation, air conditioning) environments. Such blades do not operate under conditions such as the turbofan blades of the claimed invention. Therefore, Chou fails to correct the deficiencies of Dorman.

Further, each of claims 1-3 has been amended to require that the laminar-to-turbulent boundary layer transition control feature be positioned at the low-pressure side surface of the

respective fan blade. Chou does not disclose or suggest such a feature, as the Chou only places mechanisms 21a-c on the pressure side surfaces of his blades.

In view of the above, the combination of Dorman and Chou fails to disclose or suggest the claimed invention and it is respectfully requested that these rejections be withdrawn.

The remaining claims all depend from claims 1-3 and are believed allowable for the same reasons as given above with respect to claims 1-3, as well as for the further limitations contained therein. Therefore, it is respectfully requested that the remaining rejections of the claims be withdrawn as well.

In view of the above, it is believed that the application is in condition for allowance and such a Notice is respectfully requested. If anything else is needed to place the application in condition for allowance, it is kindly requested that the undersigned be contacted.

Respectfully submitted,

Timothy J. Klima
Reg. No.: 34,852

Harbin King & Klima
500 Ninth Street SE
Washington, DC 20003
Ph: 202-543-6404
Fax: 202-543-6406